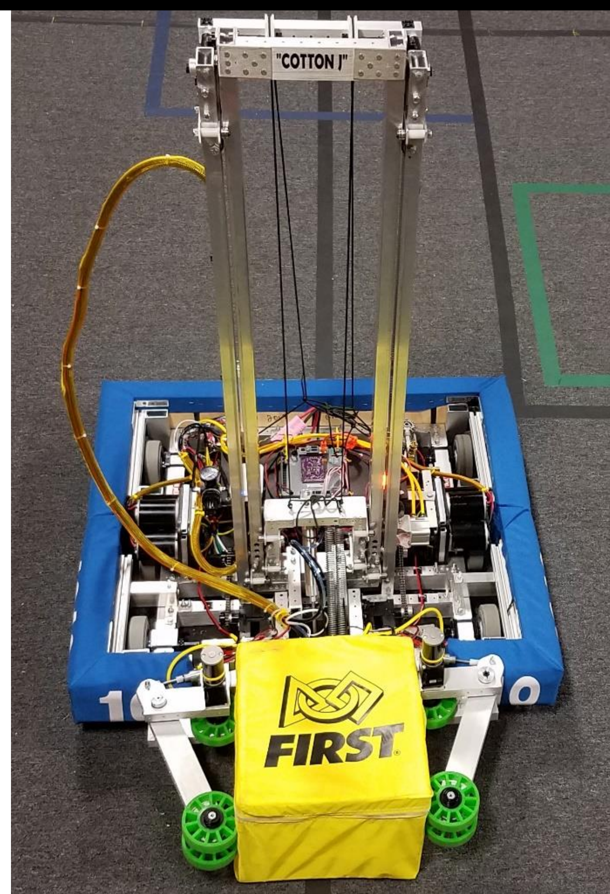
2018

"Cotton J" Technical Binder



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BLACKWATER ROBOTICS

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GAME ANALYSIS

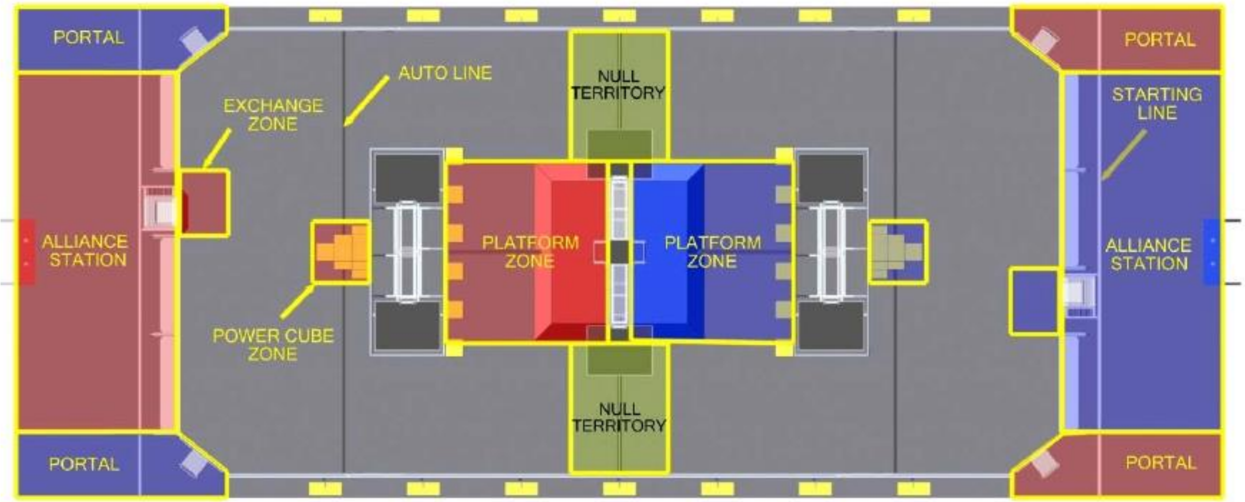


Table 4-1: FIRST® POWER UP^{SM} rewards

Action	Criteria	MATCH Points		Ranking Points
		AUTO	TELEOP	
AUTO-RUN	For each ROBOT that breaks the vertical plane of the AUTO LINE with its BUMPER at any point in the AUTO stage	5	-	-
OWNERSHIP	SCALE	2 + 2/sec	1 + 1/sec	-
	ALLIANCE'S SWITCH	2 + 2/sec	1 + 1/sec	-
VAULT	For each POWER CUBE placed in the VAULT	-	5	-
PARKING	For each ROBOT fully supported by the SCALE (either directly or transitively), not at all in the opponent's PLATFORM ZONE, and has not CLIMBED	-	5	-
CLIMBING	For each ROBOT fully supported by the SCALE (either directly or transitively) with BUMPERS fully above the BRICKS at T=0, not in direct contact with their PLATFORM, and not at all in the opponent's PLATFORM ZONE	-	30	-
FACE THE BOSS	All three (3) ALLIANCE ROBOTS have CLIMBED or two (2) ROBOTS have CLIMBED and the ALLIANCE has played the LEVITATE POWER UP	-	-	1
AUTO QUEST	ALLIANCE completes three (3) AUTO-RUNS and has OWNERSHIP of their SWITCH at T=0 of the AUTO stage	-	-	1
Win	ALLIANCE's final MATCH score exceeds their opponents'	-	-	2
Tie	ALLIANCE's final MATCH score equals their opponents'	-	-	1

POWER UP

POWER UP scoring being based on seconds of ownership is significantly different from past years and required a new way of looking at the game. Not only do we have to score POWER CUBES, but we have to utilize both our SWITCH, the opponent's SWITCH, the SCALE, and the VAULT to our advantage.

On the second day of build season we invited local teams to our shop to discuss game strategy and play a "human game." These scenarios helped the teams in attendance to see how a full 3 vs 3 match might play out.

Through using different scenarios to play simulated matches, we came to some conclusions:

- Individual robots should focus on specific scoring processes (opponent SWITCH, SCALE, or our SWITCH + EXCHANGE)
- Fast cycles of POWER CUBES from our Human Player PORTAL to the opponent's SWITCH were hard to stop
- LEVITATE POWER UP should be utilized <u>every</u> match
- Stacked pyramid of POWER CUBES is best shuttled into the EXCHANGE to fill the VAULT
- Visibility to the opponent's SWITCH is bad
- Autonomous mode flexibility is a must
- The opponent's strategy will largely effect our strategy during the match

Strategy

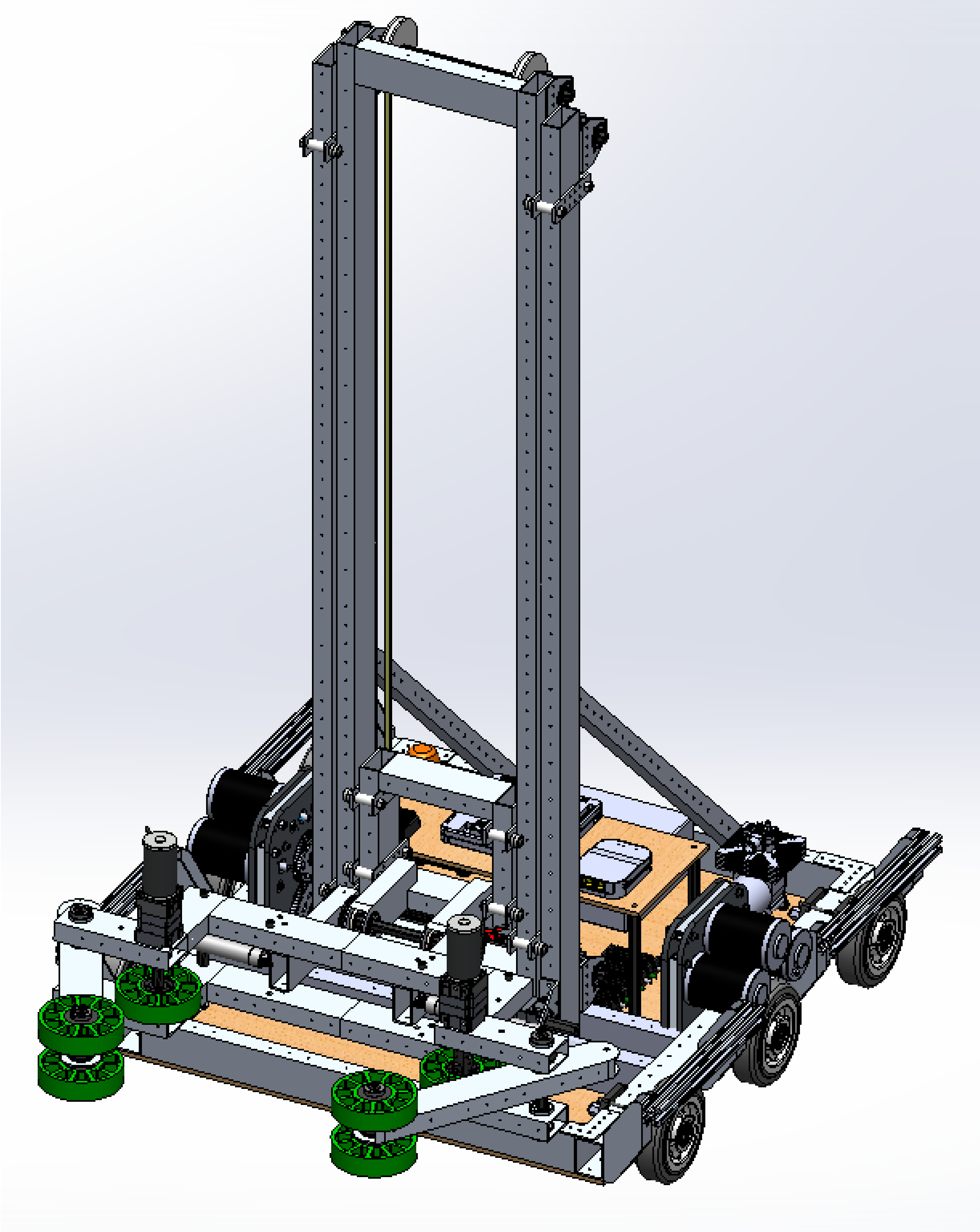
Our top priority is to rank as an alliance captain by winning matches and gaining extra Ranking Points. Autonomous is key in this game. Our estimate is that the autonomous Ranking Point should be easier to obtain than the End Game Ranking Point, but we have to rely on alliance partner actions for both.

We expect that an alliance that can take ownership of the SCALE in autonomous will win the match in the majority of cases. However, since taking ownership of our SWITCH in autonomous is more beneficial to our Ranking, we aim to position ourselves with a second Power Cube and ready to score in the SCALE at the first moment in Teleop. In Playoffs, our focus will be gaining ownership of the SCALE in Autonomous because Ranking Points will no longer be available. As we continue developing autonomous routines through the season, we strive to score two Power Cubes in autonomous.

Priority List

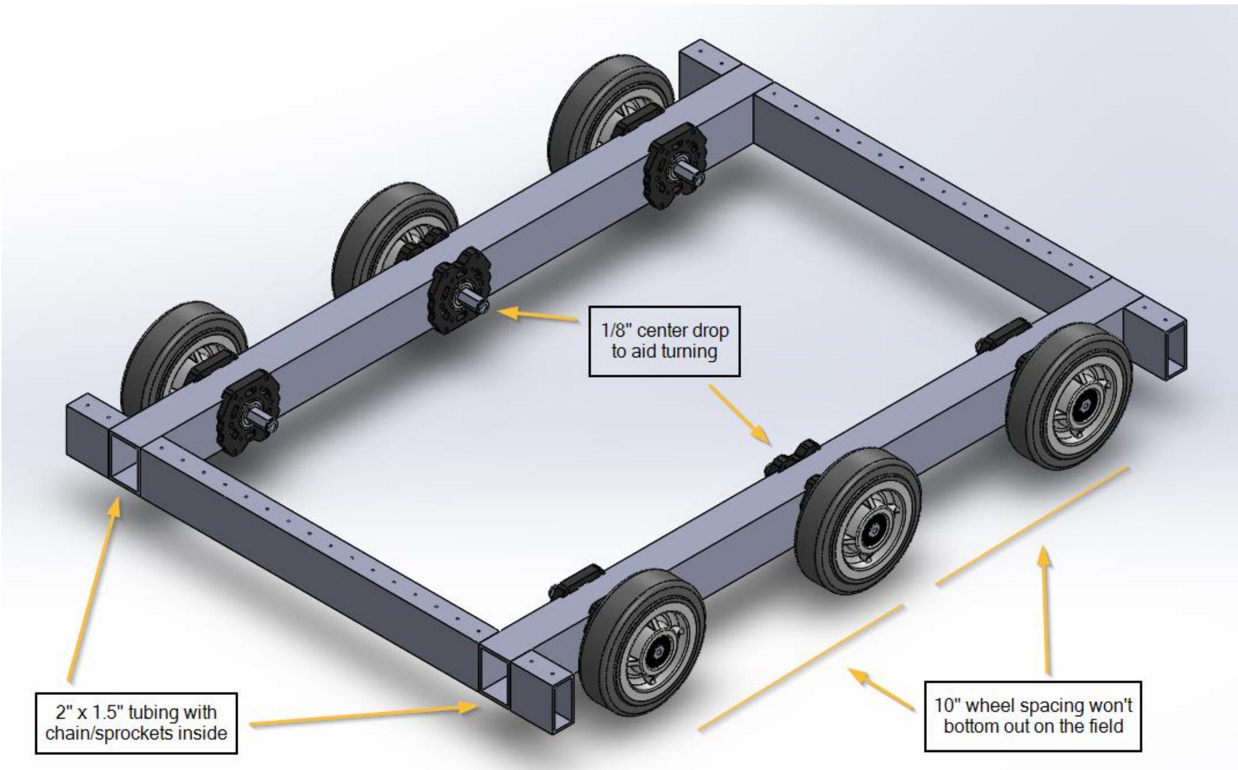
1. **Drivetrain**
   a. Fast and powerful
   b. Light but strong
   c. Low center of gravity but ground clearance for the PLATFORM
2. **Intake**
   a. "Touch-it, own-it" intake. Don't struggle to obtain cubes.
   b. Short and wide cube orientations
   c. Stability – don't drop the cube once we have possession
3. **Lifting mechanism**
   a. Elevator or arm
   b. Scale-capable height – 6'3"
   c. Doubles as climbing mechanism
4. **Autonomous**
   a. Switch scoring crucial to earning a Ranking Point in Qualification matches
   b. Multiple reliable autonomous modes for Playoffs
      i. Switch-preferred
      ii. Scale-preferred
      iii. Multiple cubes
5. **Climbing**
   a. Lowest priority due to Levitate Power-Up accessibility
   b. Other teams may have ramps or lifting abilities
   c. Climbing mechanism dependent upon elevator/arm mechanism

DESIGN



Chassis

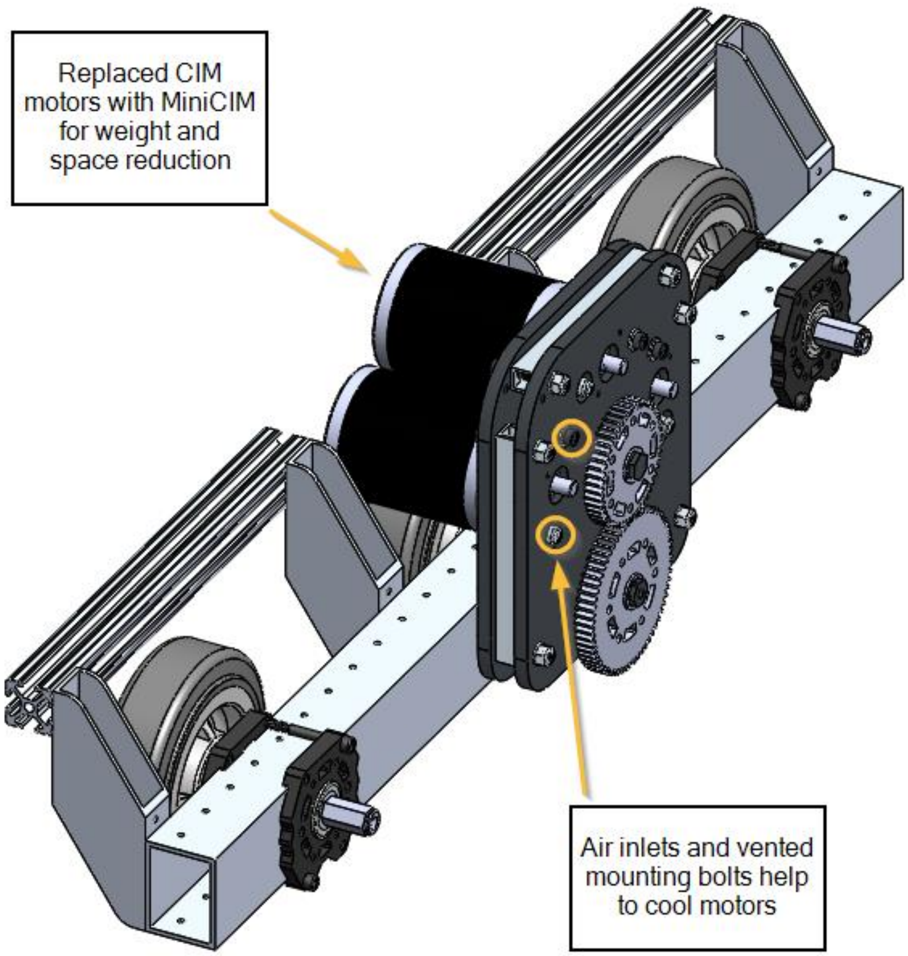
The drive chassis is constructed in the West-Coast style that we used in both 2014 and 2017. West Coast Drive places the wheels on the outside of the frame. This familiar style provided a design advantage when coupled with wider 2" x 1.5" aluminum tubing for the drive rails so that chain and sprocket could be run inside the tubing from the center driven axle to both front and rear axles. While utilizing the chain-in-tube design that we also used in 2016 serves to save space, construction has to be precise since the chains are not easily maintained.



The chassis later had to be made wider to accommodate the width of the intake. The entire frame nearly meets the maximum dimensions at 28" long x 32" wide. A small center drop on the driven axle, created by flipping the orientation of the Versa Block sets, assists with turning the six wheel chassis.

Flipped Gearboxes

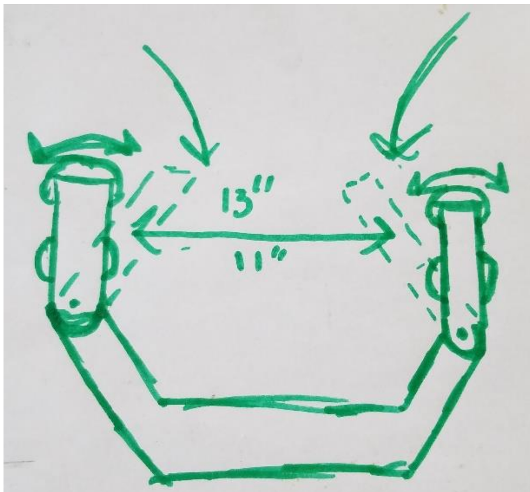
In collaboration with Team 2363 – Triple Helix, we implemented completely custom "flipped gearboxes." By flipping the motors around and over the drive wheels, we gained back approximately 8" of valuable interior space. To make the motors fit within the frame perimeter, the standard CIM motors were replaced with Mini-CIMs. There is also some evidence from discussion by Vex Robotics engineers that a six Mini-CIM drive may even have better performance on a robot in match conditions.



Included in the flipped gearboxes are 5/32" pneumatic inlets and vented mounting bolts. This combination allows air discharged from our pneumatic cylinders, which would normally be wasted, to flow through the motors as a passive cooling process.

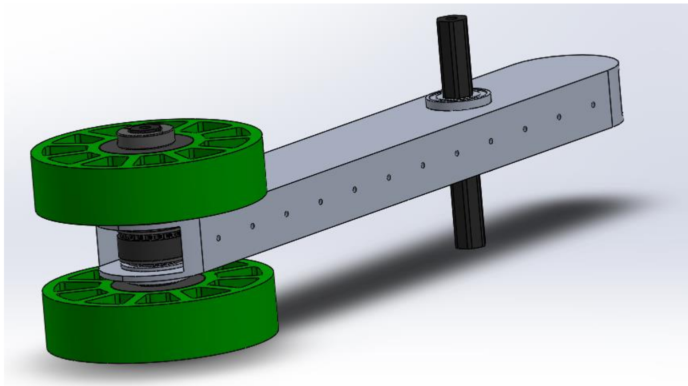
Intake

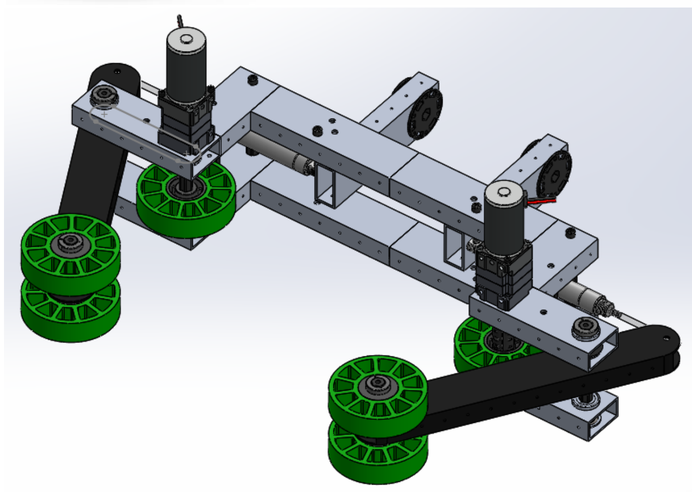
Intake development began with testing available wheels to find an option that would grip the fabric of the cube cover. Students began work on two intake prototypes: a wheeled design and a claw design (pictured below).

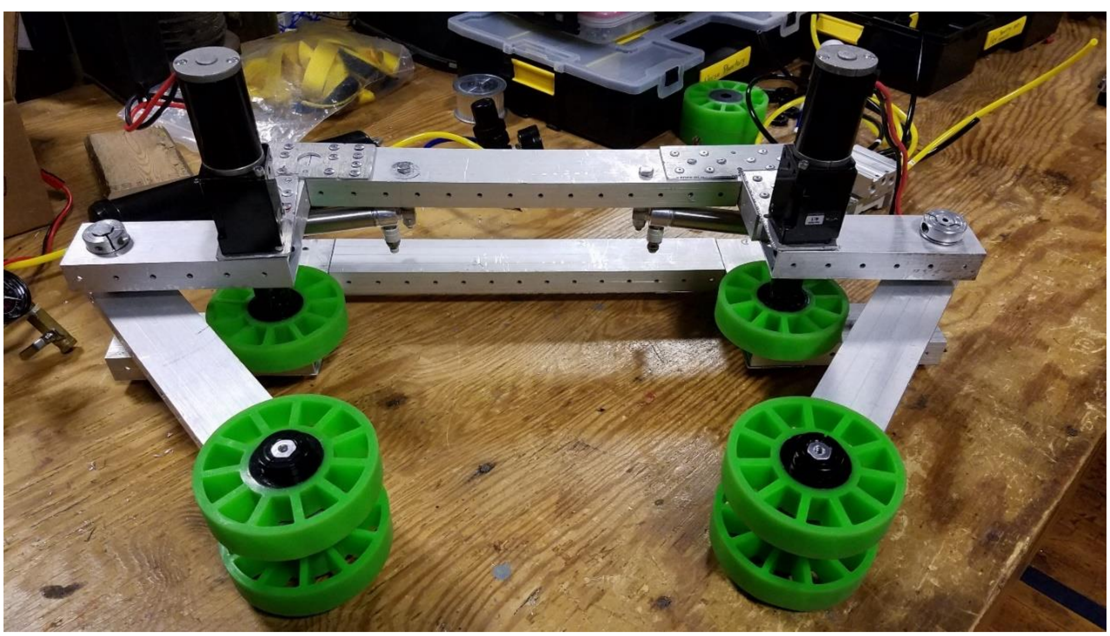


The claw prototype continued until wheels were added, then the students joined forces on a final wooden prototype. After deciding on the green complaint wheels, we modified the prototype dimensions to find a solution for both the wide and narrow sides of the cube. The fabric cover across the open side of the cube posed the largest problem so we added pneumatic cylinder actuated arms to ensure appropriate pressure could be applied to the cube at all times.

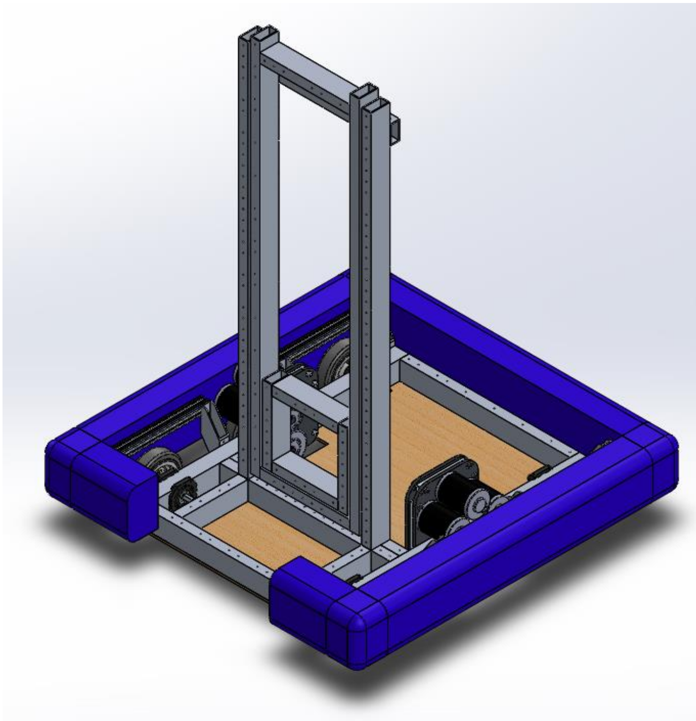
Once we were happy with a working wooden prototype, the design was moved into Solidworks to determine final construction methods. To make the total intake dimension thinner, belts and pulleys powering the wheels were moved inside the metal tubing. The arms have since been changed to plastic tubing creating nearly one pound in weight reduction.







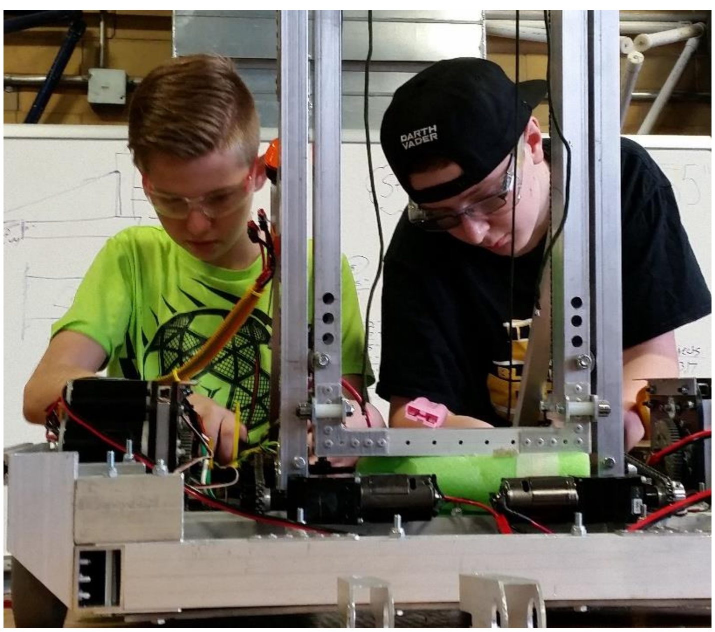
Elevator

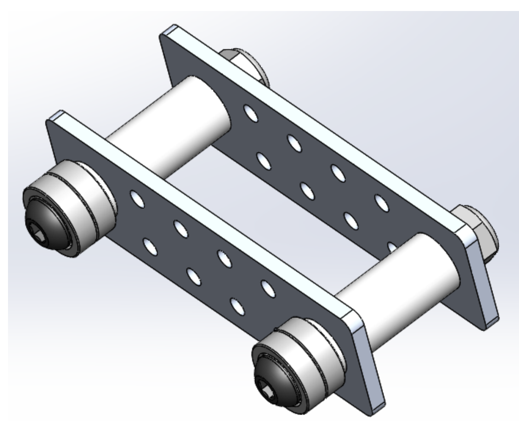


Using our team's veteran standing to our advantage, we improved upon our 2011 elevator design by utilizing more modern construction techniques to develop a sturdy double-stage elevator from 2x1 aluminum tubing.

Initial elevator design (shown at left) was too wide once we added the intake. The way we needed the intake to flip vertically would make the intake motors hit the elevator uprights. The elevator was redesigned to be 13" wide.

COTS available linear motion kits proved to be too wide for the new 13" dimension, so we developed our own custom linear bearing mounts using R4 bearings (shown below).

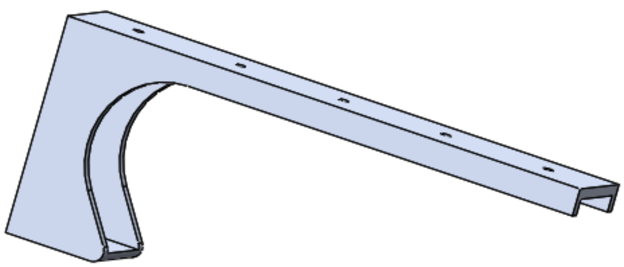




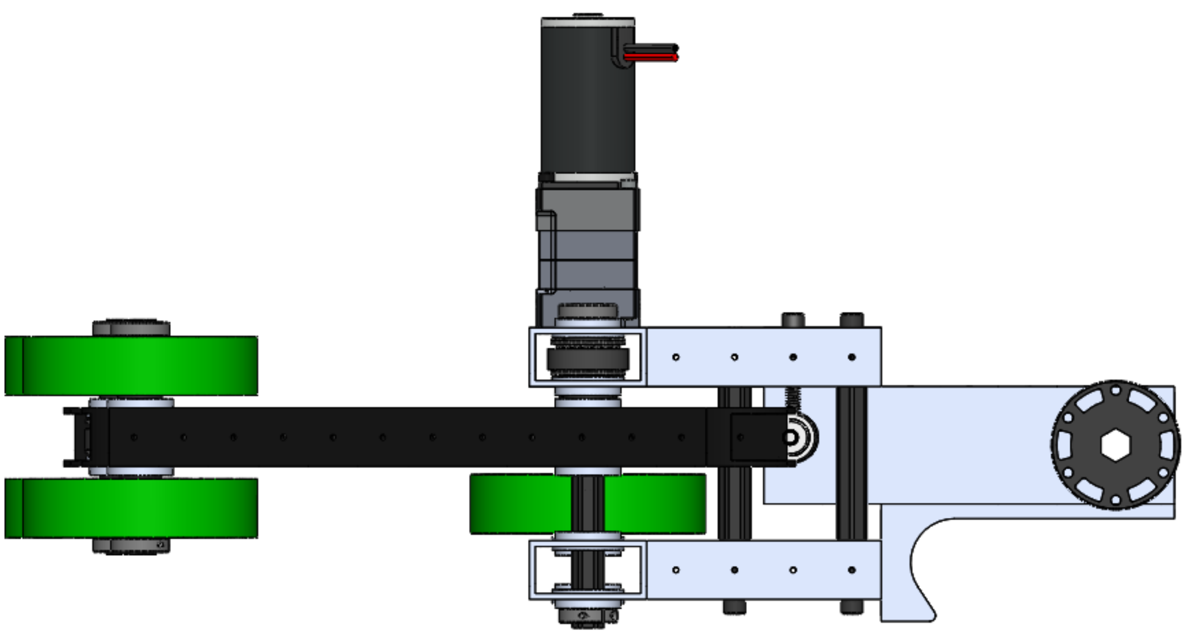
Climber

With only ten pounds remaining before reaching the 120 pound weight limit, we had to become creative when developing our climbing mechanism. Three different options were evaluated:

1. Lifting with the elevator by adding a second elevator motor and gearbox
   Pros: Mostly already in place, not a lot of additional weight
   Cons: Unable to easily stop back-drive
2. Hook carried by the elevator, winch system similar to our 2014 or 2017 robot
   Pros: Easy to hang a hook from the elevator that already extends to the correct height
   Cons: Additional weight for winch gearbox
3. Tape measure hook system popular in FTC
   Pros: Very lightweight
   Cons: Complicated mechanism, still requires extra gearbox (or two)



We chose option one and added a second elevator motor and gearbox to handle the weight of the robot with bumpers. Hooks for the hanging bar were manufactured out of 2x1 tubing and placed on the bottom of the intake. When the intake is vertical, the hooks can be lifted above the hanging bar. A pneumatic cylinder was added to the side of the elevator to serve as a locking pin, requiring no winch mechanism.



Programming and Controls

Each side of the drivetrain is controlled by one Talon SRX master and two Victor SPX in “follow” mode. Utilizing follow mode, each master controller is programmed then the followers communicate with the master over CAN (Controller Area Network) to get their instructions.

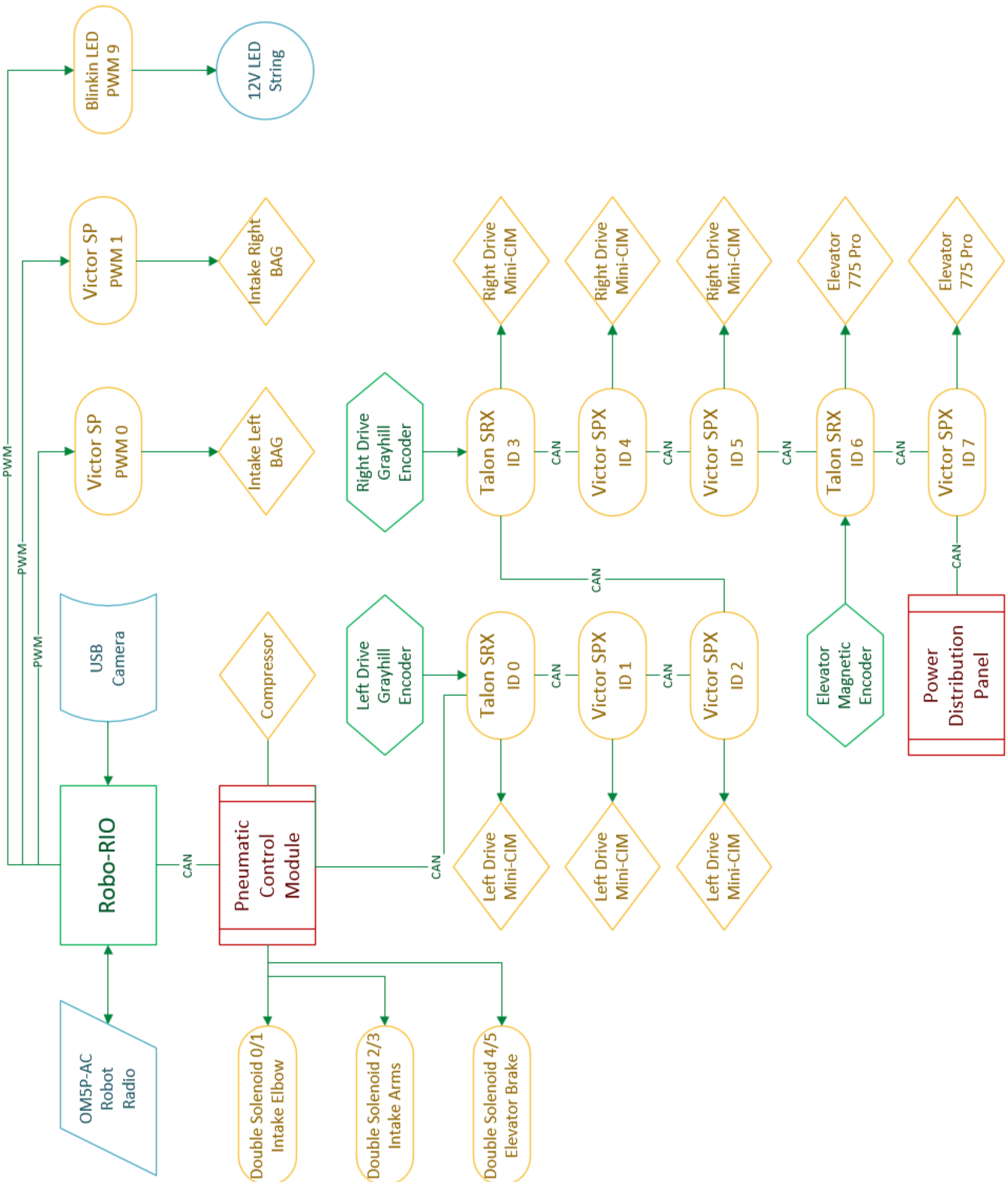
Quadrature encoders for straight driving when coupled with PID control in autonomous are connected to the Talon SRX utilizing the built-in data port and encoder breakout board.

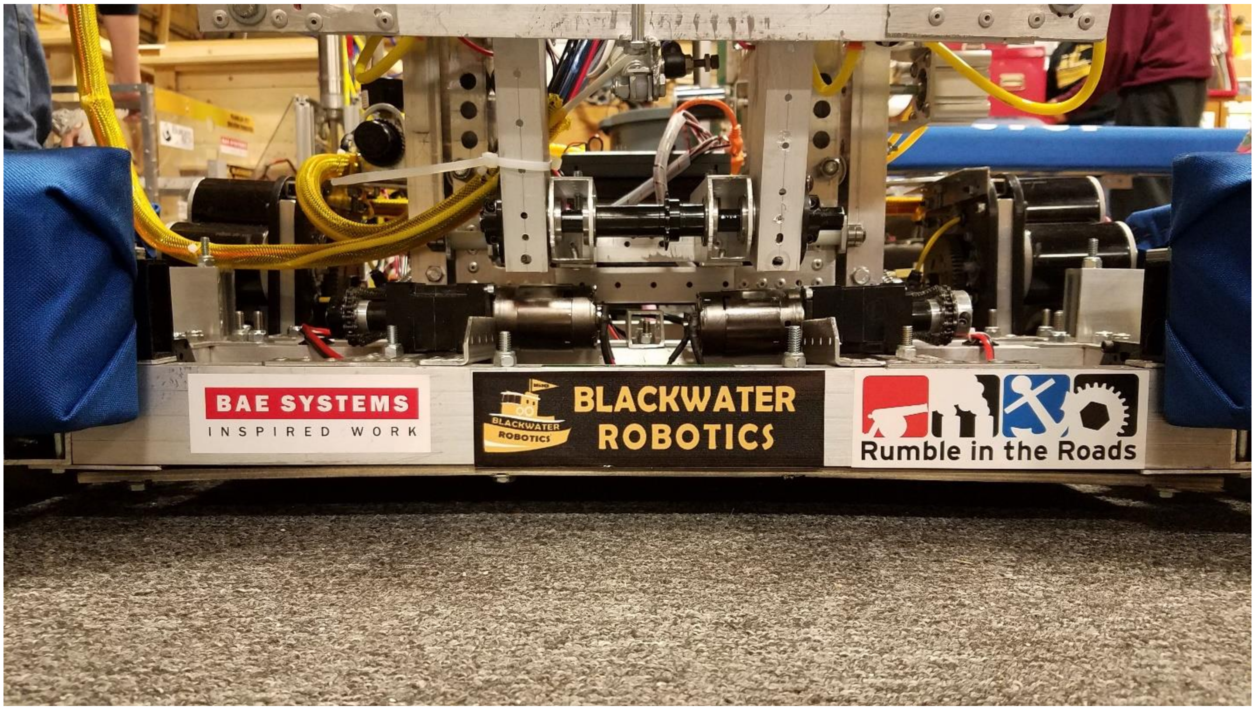
Voltage Compensation is enabled for the drivetrain motor controllers, limiting top-end speed but increasing reliability. 100% throttle is pushed to the motors as 10.5 volts rather than 12 volts providing a more reliable experience as voltage diminishes through the match.

An integrated encoder on the elevator lift motor gearbox prevents top-end jams while a limit switch at the lowest elevator point resets the encoder count each cycle for higher accuracy.

LED lights on both elevator uprights provide quick feedback to the driver by changing colors when a cube is in control.

Communications Schematic





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